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APPLICATION NUMBER: *60/557,230*
FILING DATE: *March 29, 2004*
RELATED PCT APPLICATION NUMBER: *PCT/US04/19418*

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

Substitute for PTO/SB/16 (08-03)

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV316084284US

INVENTOR(S)		
Given Name(first and middle[if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Kalford C.	Fadem	Louisville, Kentucky

☐ Additional inventors are being named on the ____ separately numbered sheets attached hereto.

TITLE OF INVENTION (500 characters max)

ACTIVE, MULTIPLEXED DIGITAL NEURO ELECTRODES FOR EEG, ECG, EMG APPLICATIONS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 3 ☐ CD(s), Number

☒ Drawing(s) *Number of Sheets* 5 ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD FOR PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☒ Applicant claims small entity status. See 37 CFR 1.27 ☒A check is enclosed to cover the filing fees	**FILING FEE Amount ($)** $80.00

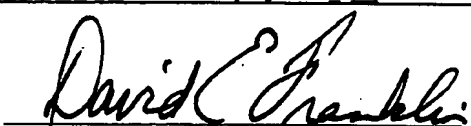
☒ The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account **06-2226**

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government

☒No

☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted,

SIGNATURE 

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Date March 29, 2004

REGISTRATION NO. 39,194

Docket Number 103701.0523542

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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U.S. PROVISIONAL PATENT APPLICATION

ACTIVE, MULTIPLEXED DIGITAL NEURO ELECTRODES FOR EEG, ECG, EMG APPLICATIONS

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March 29, 2004
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Matthew G. Burgan
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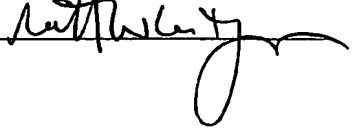

Signature

Neuronetrix Active Electrode
Patent Summary

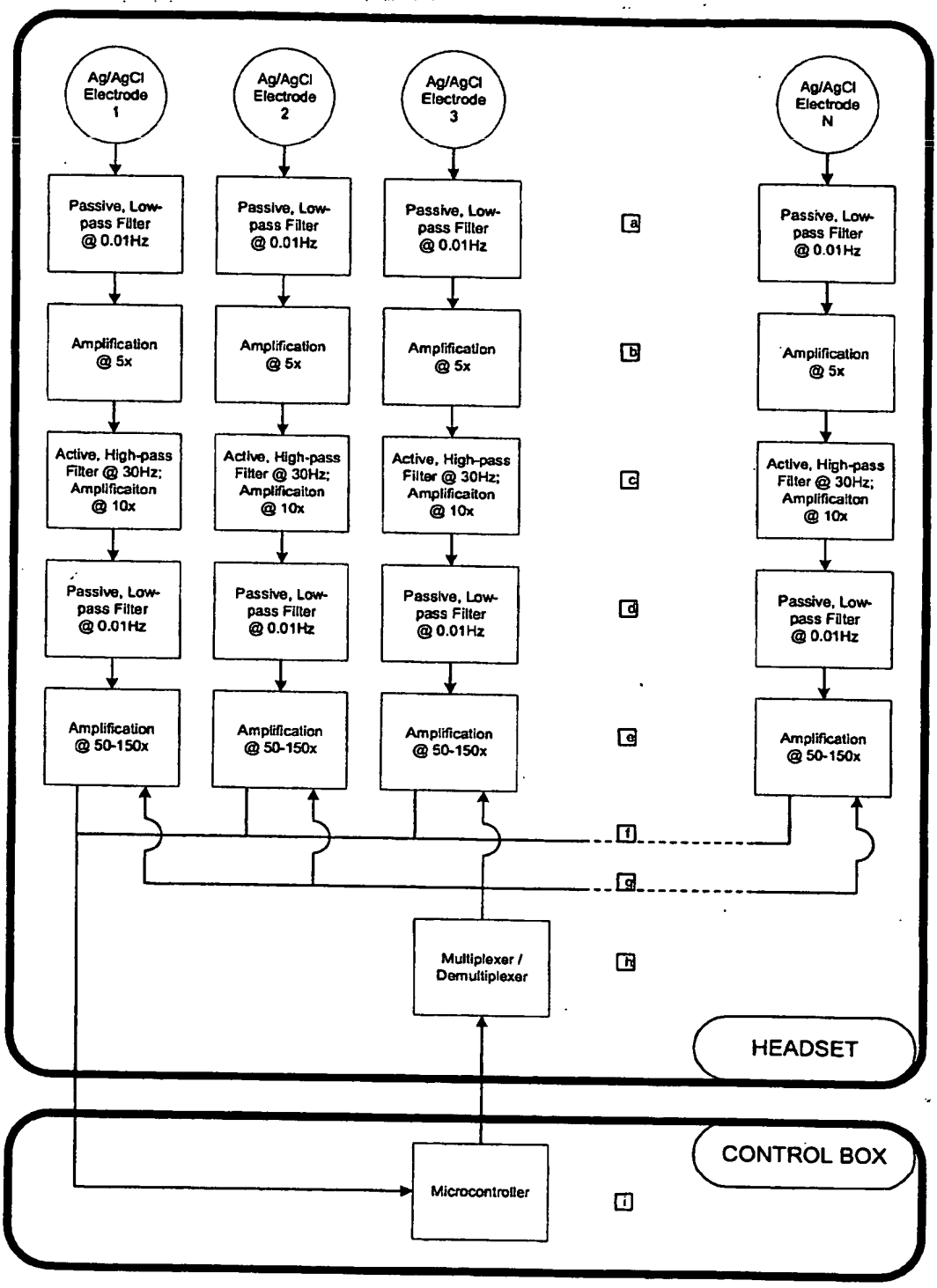
Electroencephalograms (EEGs) have traditionally been the most difficult electrogram measurement to acquire from a hardware standpoint. The signal amplitude for EEGs is tens to hundreds of times smaller than that of ECGs or EMGs. The most common EEG application involves using numerous Ag/AgCl electrodes contained within a net or hat placed on the scalp of the patient, with each electrode individually tested for low impedances of less than 10 kΩ. To foster low impedances, technicians often will abrade the scalp of the patient to remove the stratum corneum and use electrolyte gels or saline solutions to couple the electrode to the skin. The typical EEG net or hat then connects to the hardware box using a cable several feet in length, subjecting the microvolt-level EEG signal to ambient noise that is many times greater than the signal itself.

The net effect is the designer is challenged to extract the very small signal with a poor signal-to-noise ratio in a very narrow frequency range (typically 0.05 to 40 Hz). The design must then incorporate high-order filters with high gain (5000-20000 times) and sharp roll-off, to ensure that the only the desired signal is recorded.

The Neuronetrix READS system is designed using a revolutionary approach to the recording of EEGs. This system uses eight active electrodes and a single reference electrode to diagnose low-level brain dysfunctions such as hearing loss, and high-level brain dysfunctions such as dyslexia. This system incorporates an active, digital electrode which amplifies and digitally converts the EEG signal at the source, thereby eliminating noise and signal degradation issues.

This is to date the most integrated and advanced electrode designed for any electrogram measurement. To eliminate the poor SNR problems seen in EEG recordings, we are designing the amplification and filtering electronics into each electrode. Each of the eight electrodes contains a 4-pole low pass filter set at 30Hz and a 2-pole high-pass filter set at 0.01 Hz, with an overall filter gain of 10. Each electrode also contains a dual instrumentation amplifier with a fixed gain of 5 in the first stage, and a variable gain in the second stage for an overall gain of 5000-15000. The variable gain is set by digital potentiometers, with each electrode receiving a resistive input from a distinct digital pot.

These active electrodes are also the first such electrodes to contain high-resolution A/D conversion on board, so that the only output from each electrode is a digitized signal at a point physical located less than 15mm from the Ag/AgCl electrode itself. Each electrode contains a single 16-bit A/D converter operating on a Serial Peripheral (SPI) bus, allowing individual electrodes to be "activated" using a chip select function selected through a demultiplexer also on the SPI bus. This allows all electrodes to share a single digital output connection and reduces the number of wires between the headset and the control box.



a) Passive high-pass filter using an RC network to eliminate DC offset voltages

b) First stage instrumentation amplifier with a fixed gain of 5 provides a small amplification before filtering, as well as removes common-mode AC voltages present on the EEG waveform with respect to the reference voltage. Typical CMRR > 90db at 50/60 Hz.

c) 4-pole active low-pass filter providing 10x amplification with a 0.5db cutoff frequency of 30Hz. Approximate attenuation of 90db per decade, with an attenuation of -30db at 60Hz.

d) Passive high-pass filter using an RC network to eliminate DC offset voltages

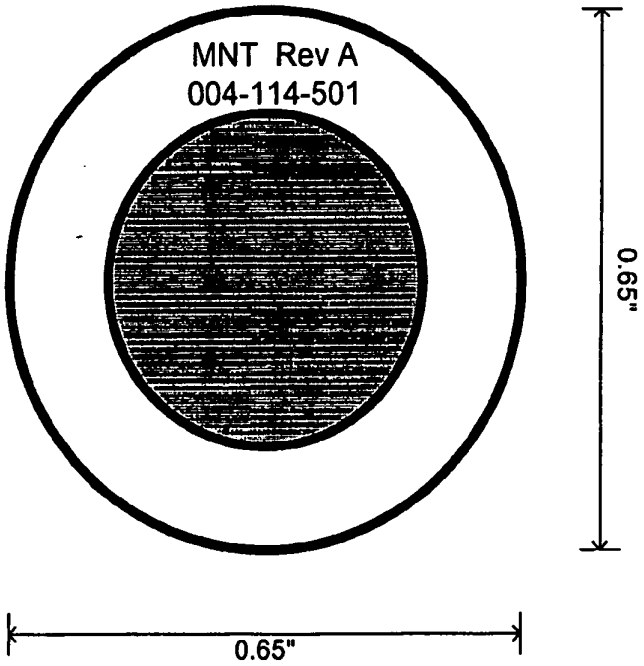
e) Second stage instrumentation amplifier with a variable gain of 50-150 provides the highest power amplification on the filtered signal, which reduces power overall power consumption and provides the cleanest signal. Typical CMRR > 90db at 50/60Hz.

f) Multiplexed digital output reduces wire count by compressing N outputs into a single wire

g) Demultiplexed chip select allows selection of individual electrodes for sampling and analog-to-digital conversion

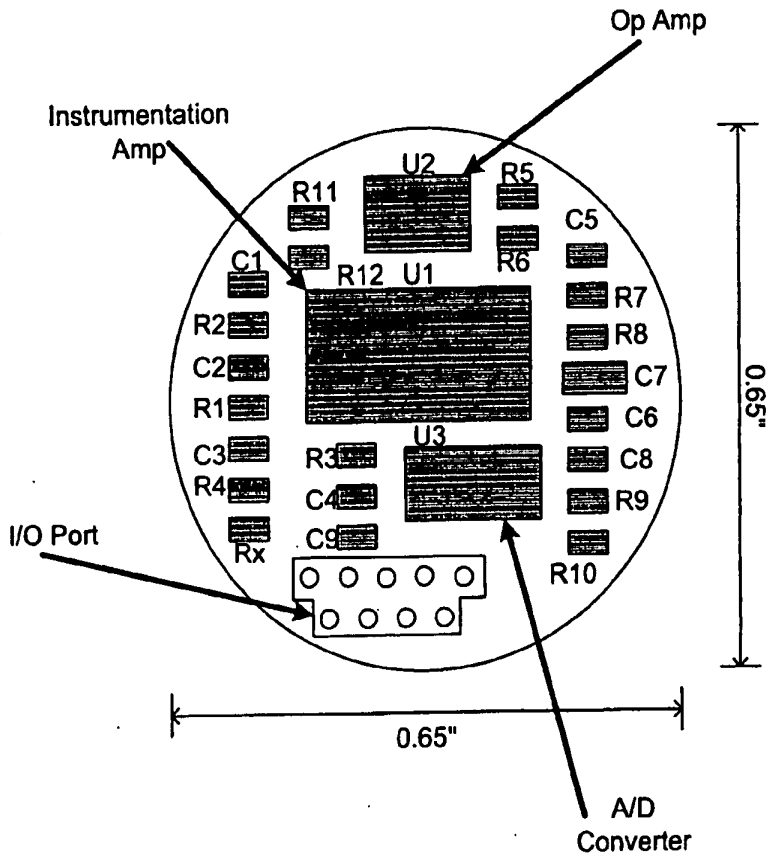
h) Multiplexer/Demultiplexer facilitates (g) above

i) Microcontroller in the control box provides sampling protocols



Notes:

1) Shaded circle indicates pad for snap connetion
2) Annular rings indicate input/output wire connections
3) Material 0.31" FR4
4) Minimum trace/space 0.006"
5) Scale 5:1



Notes:

1) Shaded boxes indicate part placements
2) Annular rings indicate input/output wire connections
3) Material 0.31" FR4
4) Minimum trace/space 0.006"
5) Scale 5:1
6) Text is present as silkscreen layer on circuit board

Actual Size:

LIST OF MATERIALS

Part: 005-114-501	Product: LDH-117 Active Electrode

ITEM	MNT P / N	QTY	DESCRIPTION	MFG P/N	MANUFACTURER	REF DES
1		1	IC INST AMP LP CMOS R-R 14-TSSOP	INA2331AIPWR	Burr-Brown / TI	U1
2		1	IC RAIL-TO-RAIL OP AMP SOT23-8	OPA2347EA/250	Burr-Brown / TI	U2
3		1	IC ADC MICRPWR SMPL 16BIT 8-MSOP	ADS8325IBDGKT	Burr-Brown / TI	U3
4		4	RESISTOR 3.3M OHM 1/16W 5% 0402	ERJ-2GEJ335X	Panasonic-ECG	R1,R2,R3,R4
5		1	RES 17.4K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1742X	Panasonic-ECG	R5
6		1	RES 158K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1583X	Panasonic-ECG	R6
7		1	RES 143K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1433X	Panasonic-ECG	R7
8		1	RES 14.3K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1432X	Panasonic-ECG	R8
9		1	RES 22.6K OHM 1/16W 1% 0402 SMD	ERJ-2RKF2262X	Panasonic-ECG	R9
10		1	RES 15.4K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1542X	Panasonic-ECG	R10
11		1	RES 10.0K OHM 1/16W 1% 0402 SMD	ERJ-2RKF1002X	Panasonic-ECG	R11
12		1	RES 90.9K OHM 1/16W 1% 0402 SMD	ERJ-2RKF9092X	Panasonic-ECG	R12
13		1	RES 1.0K OHM 1/16W 5% 0402 SMD	ERJ-2GEJ102X	Panasonic-ECG	R13
14		4	CAP CER 1.0UF 6.3V 10% X5R 0402	GRM155R60J105KE19D	Murata Electronics	C1,C2,C3,C4
15		1	CAP CERM .039UF 10% 10V X7R 0402	0402ZC393KAT2A	AVX Corporation	C5
16		2	CAP .33UF 10V CERAMIC X5R 0603	ECJ-1VB1A334K	Panasonic-ECG	C6,C8
17		1	CAP .68UF 10V CERAMIC X5R 0603	ECJ-1VB1A684K	Panasonic-ECG	C7
18		1	CAP CER .1UF 10V 10% X5R 0402	GRM155R61A104KA01D	Murata Electronics	C9